Aruljothi, Arunvenkatesh_Abstract
NC4 (Risk & Reliability Analysis Branch)
Mentor: Mark Valentine & Roger Boyer

MaRS Project

The Space Exploration Division of the Safety and Mission Assurances Directorate is responsible for reducing the risk to Human Space Flight Programs by providing system safety, reliability, and risk analysis. The Risk & Reliability Analysis branch plays a part in this by utilizing Probabilistic Risk Assessment (PRA) and Reliability and Maintainability (R&M) tools to identify possible types of failure and effective solutions. A continuous effort of this branch is MaRS, or Mass and Reliability System, a tool that was the focus of this internship.

Future long duration space missions will have to find a balance between the mass and reliability of their spare parts. They will be unable take spares of everything and will have to determine what is most likely to require maintenance and spares. Currently there is no database that combines mass and reliability data of low level space-grade components. MaRS aims to be the first database to do this. The data in MaRS will be based on the hardware flown on the International Space Stations (ISS). The components on the ISS have a long history and are well documented, making them the perfect source.

Currently, MaRS is a functioning excel workbook database; the backend is complete and only requires optimization. MaRS has been populated with all the assemblies and their components that are used on the ISS; the failures of these components are updated regularly. This project was a continuation on the efforts of previous intern groups. Once complete, R&M engineers working on future space flight missions will be able to quickly access failure and mass data on assemblies and components, allowing them to make important decisions and tradeoffs.

Duties

The primary objective for this internship was to identify and enter as many masses as possible for the components within MaRS. At the start of this internship, very little mass data had been entered. The data for the mass of the components was sourced from many different internal ISS databases, or by contacting the manufacturer. This required sifting through pages of information until the mass was found. In few special cases, the mass was calculated using basic geometry and material density. Along with entering mass data, an important task was to document methods used for finding and validating masses.

Failure data entry was another task of this internship. This was a sole effort, so extra care was taken to be precise. Failures had to be analyzed to determine if they were random or not. Random failures were most important for the future statistical analyses that engineers will deploy. Also failures were categorized as hardware or software and attributed to a single component. This helps identify which components fail most often. Failures are shared from component to assembly.

Just as important as these duties were communication and teamwork. Since I was working in a team it was important to communicate with my partner. We had to plan out the work that we would do on MaRS to ensure we did not repeat tasks. To do this we requested a share drive that enabled us to share files instantly. This increased our communication bandwidth and we were able to complete tasks quicker with less confusion.

Accomplishments

All the tasks and duties outlined above were accomplished. Approximately 39% of the 81,815 components had their masses entered. A handover document was prepared that outlined the best

process used to find masses. The handover document will save the next interns a lot of time in searching for the best mass retrieval methods. A total of 84 new failures were added, some new, and many older that had been overlooked. Using the knowledge gained from entering failures, a section was added to the handover document that explains methods in demystifying failures and making them easier to characterize.

Additionally, I was able to utilize Visual Basic to create subroutines to assist with the tasks associated with this project. This was useful when combing through the large amounts of mass data. I developed two important subroutines. One that would fill in the mass for all components of the same series. Another to compare MaRS along with other excel workbook sources and copy the relevant mass data. Both of these saved a considerable amount of time and effort.

Finally, a major accomplishment was implementation of forms to make using the database easy. The search form provided the user with a better interface that was simpler to use than the previous method. I also developed a main menu form that allows the user to only see the parts of the database they were interested in. Since this database contained a large amount of data, it was becoming unwieldy. Both of these solutions were designed to make it more practical and approachable.

Experience

This internship provided a valuable opportunity to learn about risk and reliability analysis. I never imagined how extensively used it was. I learned about many processes and tools including: risk mitigation, fault trees, system modeling, simulations, and PRAs. Most importantly, I learned about how NASA was using all of these techniques to make space exploration safer. Human space flight is inherently not safe, but the Safety and Mission Assurance directive works constantly to minimize the risks to crew and ground personal.

JSC as a whole has also made an impression on me. Working here is completely different than anything I have previously done. JSC fosters a lot of inclusion by hosting a wide variety of groups. The Employee Resource Groups provided a variety of useful events that allowed me to network and learn about the people working at this center. I was given many chances to give back to the community. I volunteered at Trash Bash with JSC's green team, FIRST Lone Star Regional with my mentor and at Microsoft Youth Spark with the other interns.

In addition, I was a part of NASA on Campus, and the Intern Video committee. Participating in these committees gave me a chance to share my passion for space and make JSC intern history. The Intern family here is also very encouraging, there is always a sense of inclusion. JSC even helped me decide on my future education. I am happy to say that I applied to my college's graduate school for Robotics and Control this semester. A decision both my mentors helped me make.

In conclusion, this internship has been a fulfilling experience. I was able to be privy to some amazing engineering and science. I am glad I decided to relocate and try something new. It will leave a lasting impact on me and influence my decisions in the future. I hope that my next internship will be at NASA and possibly even JSC.

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(Picture of the interns acting silly. The picture is cropped due to its size.)